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Cricoid Pressure: Improving Performance through Education and Training

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Abstract

Passive regurgitation of abdominal contents during endotracheal intubation is a significant concern in the operating room. Pulmonary aspiration of gastric contents can trigger a sequence of events that may result in injury to the patient. An effective means of reducing this risk is cricoid pressure.(1) Often, the circulating nurse is responsible for the perioperative application of the technique. Unfortunately, studies reveal a generalized knowledge deficit regarding correct application among operating room personnel.(2) This study investigated the ability of nurses to learn and retain the skill over time. Determining effective strategies to improve performance helps optimize the induction phase of anesthesia and improves patient outcomes.

Cricoid Pressure: Improving Performance through Education and Training

Background

A primary concern during the induction of anesthesia is the prevention of regurgitation during endotracheal intubation, in order to minimize the risk of pulmonary aspiration and its negative effects. Aspiration of gastric contents can trigger a sequence of events that may hinder the induction process and/or result in injury to the patient. An effective means of reducing this risk is the correct application of cricoid pressure. In addition, cricoid pressure has not only been shown to minimize regurgitation but also decreases insufflation of the stomach during bag valve mask ventilation.(3)

Reference to the use of cricoid pressure dates back to the 1770's when Cullen described Monro's use of cricoid pressure to prevent gastric insufflation during the ventilation of "drowned and seemingly dead" persons.(4) In 1961 Sellick described the specific use of cricoid pressure. Due to his experimentation with, and description of proper technique, application of cricoid pressure is also known as Sellick's Maneuver. The technique described by Sellick remains essentially unchanged today.(5)

Correct performance of this maneuver requires knowledge of the anatomy of the neck to ensure proper hand placement, application of the correct amount of pressure to occlude yet avoid injury to the esophagus, and application of this pressure for an appropriate duration to ensure confirmation of endotracheal tube placement.

The cricoid cartilage is a continuous cartilaginous ring located at the junction of the trachea and the larynx at the level of the sixth cervical vertebrae. The structure and location of the cricoid cartilage is advantageous in that as pressure is applied to occlude the esophagus the airway remains patent. Proper application of cricoid pressure involves placing the thumb and

second finger on either side of the prominence of the cricoid cartilage with the index finger above. This position provides stability, preventing lateral displacement of the cartilage. Once the cricoid cartilage is located pressure must be applied and maintained until the endotracheal tube has been inserted, cuff inflated, and the correct placement has been verified.(6) It is important to acknowledge the idea that not all patients need the application of the technique, as certain populations have a higher incidence of regurgitation during the induction of anesthesia. The general categories of patients at an increased risk of regurgitation are those with an increased gastric volume or gastric pressure, and those with impaired laryngeal function.(7)

It is essential that the correct amount of force be applied when performing cricoid pressure. The amount of force applied during the application of cricoid pressure is measured in Newton's (9.81 N = 1 kg = 2.2 lb). However, kilograms (kg) are a more easily understood unit of measure and have been utilized successfully in prior experiments on cricoid pressure. The amount of force required to occlude the esophagus, preventing regurgitation, has been shown to be 3-4 kg. Pressure in excess of 4 kg may cause occlusion of the airway or interference with the laryngoscopic view, while pressure less than 3 kg is ineffective in occluding the esophagus and thus, preventing regurgitation.(8)

Problem Statement

In many settings, the circulating nurse is requested to apply cricoid pressure. Consequently, it is extremely important that this individual be knowledgeable and proficient in delivering the appropriate pressure needed to prevent passive regurgitation. The literature regarding cricoid pressure intended for nursing personnel is inadequate. Insufficient literature and limited studies on learning and retention of this skill necessitates that further research is

warranted. In addition, recruiting subjects from populations that actually apply cricoid pressure may provide greater validity of data and increase the usefulness of the research.

Purpose of Study

The purpose of the study was to determine if education and training improved performance of cricoid pressure application and to assess whether or not knowledge and skills learned during an educational intervention were retained over a period of time.

Research Questions

The research questions guiding the study were:

1. Do operating room nurses know how much pressure to apply and do they currently apply the correct amount of cricoid pressure for the duration of the maneuver?

2. Will education improve knowledge of correct pressure and the percentage of nurses applying the correct pressure for the duration of the maneuver?

3. Will the knowledge and skills learned be retained over time?

Conceptual Framework

Learning theory suggests effective learning in adults is different than in children and adolescents. Unlike children and adolescents, adult learning utilizes prior life experiences that play a major role in perception and interpretation of new information.(9) Consequently, adults process newly acquired or reinforced knowledge differently. This concept influences the design and implementation of remedial training on key tasks such as application of cricoid pressure in the operating room setting.

According to adult learning theory, because adults process information differently and have varying abilities, instructional techniques must be analyzed for effectiveness. Adaptability and variety is essential to the success of adult learners. Use of a single teaching method does not

necessarily meet the needs of all learners within a group.(10) Educational approaches frequently used in the healthcare setting are hands-on training and didactic tutorials. These methods enhance the ability of learners to comprehend information, expanding their knowledge base and incorporating it into clinical practice. Therefore, adult learning principles influence the design and implementation of remedial training on key tasks such as application of cricoid pressure in the operating room setting. A conceptual model was developed to assist researchers in designing the proposed study and can be viewed in Figure 1.

Conceptually, cricoid pressure must be identified as warranted. If not warranted, cricoid pressure will not be utilized. If indicated, force will be applied either correctly or incorrectly. Insufficient pressure will prevent the esophagus from occluding which increases the possibility of passive regurgitation, increasing risk for aspiration. Secondly, excessive pressure may cause laryngeal distortion, obstruct the view of the vocal cords, or impair ability to successfully ventilate. As discussed previously, correctly applied cricoid pressure will occlude the esophagus, decrease risk of regurgitation, and minimize the risk of aspiration.

Literature Review

Pertinent recent literature can be divided into two general categories: 1) appropriate application technique, and 2) teaching recommended cricoid pressure levels. Though a tool such as a cricoid yoke exists to apply constant and precise pressure, a manual method allows for greater assurance of proper application. Additionally, a cricoid yoke may obstruct one's view of the vocal cords and potentially hinder appropriate endotracheal tube placement. Cook developed a blinded, randomized protocol to investigate the efficacy of one and two-handed techniques. A two-handed technique refers to one hand under the neck and the other placing traditional cricoid pressure. Providers distributed 120 subjects evenly between the two groups. A force of 40 N was

applied to the cricoid cartilage of each subject. Drapes hid the neck area from the view of the recording observers. Results indicated that in 67.5% of subjects, technique did not alter laryngeal view. However, data suggested a two-handed technique decreased view via laryngoscopy, potentially from unintentional flexion of the neck.(11)

Further research analyzed which hand provided greater consistency. Twenty subjects were recruited for an experimental study by Cook, Godfrey, Rocket, & Vanner where anesthetic assistants demonstrated force on a roll of Elastoplast tape set on an infant scale. Researchers recorded force at 15-second intervals for the first two minutes and 30-second intervals for the remainder of the five minutes. Appropriate cricoid pressure was defined as 20-45 N. Results confirmed that 60% of participants performed significantly different force applications with right and left hands. Nineteen of the twenty participants were right handed, so not surprisingly results indicated the right hand more effective.(12)

Even though application of cricoid pressure was found effective, poor performance potentially negates positive outcomes. A study by Koziol suggested that medical providers significantly underestimate appropriate force of cricoid pressure. A correlation design established differences in applied and recommended forces of 102 participants. Perioperative nurses completed an open-ended questionnaire and demonstrated on a model forces representative of those applied in clinical practice. Amazingly, only 5% of respondents identified acceptable pressure and only 13% successfully applied the recommended amount of force.(13)

Schmidt and Akeson recruited a sample of 48 anesthesia personnel to fill out a questionnaire and demonstrate simulated cricoid pressure technique on a model. Each participant applied pressure twice for a duration of 60 seconds each time. Subjects chose the side of the model pressure was applied from and used the dominant hand first. After filling out a

questionnaire participants practiced performing 10N and 30N of pressure on the model. Results from the didactic portion of the study indicated that 69% were unaware of a recommended level of force. The psychomotor portion of the study indicated that the majority of participants used ineffectively low forces when performing the technique. In addition, no significant difference was found in the force each hand was able to consistently provide.(14) This contradicts the findings of Cook et al. and suggests the need for additional research. However, results concurred with Schmidt and Akeson that operating room staff lacked sufficient knowledge and used ineffective pressure in clinical practice.

Several recent studies focused on different methods of teaching appropriate cricoid pressure to improve performance. Meek, Gittens, & Duggan used simple instructions in conjunction with a locally designed model to evaluate knowledge and performance. Researchers recruited 135 anesthesia technicians and gathered baseline data via a questionnaire and simulated pressure applied to the model. Subjects were then given the goal force of 40 N and reevaluated after a short practice session. A range of 30-44 N was considered acceptable during the data analysis portion of the study. Results indicated that approximately 50% had previously heard of a suggested force and only 33% could verbalize an appropriate number. In addition, the majority of participants performed the technique using inappropriate pressures upon gathering baseline data. After the practice session only 5.9% remained unable to provide force within the acceptable range. Results suggest that a practice session using given parameters significantly improves performance.(15)

Clayton and Vanner recruited 20 operating room personnel to participate in an experimental study. In the design, a roll of Elastoplast tape simulated cricoid cartilage and a kitchen scale measured force. Baseline data using the model was collected on forces simulating

appropriate pressure on patients. Subjects were then told the recommended force was 30 N and allowed to practice. After the session, subjects were retested. Results indicated that initially only 7.5% applied appropriate force. After the practice session, success increased to 63%.(16) The results of both Meek et al. and Clayton et al. suggest baseline knowledge was inadequate and that subjects benefited from an educational intervention.

Without retention of information, education and training have limited usefulness. Using a quasi-experimental design by Ashhurst, Route, Rocke, & Gouws, 49 certified registered nurse anesthetists (CRNAs) and anesthesia technicians used a locally designed yoke on a head and neck mannequin to gather baseline data and evaluate an educational intervention on retention of information. After gathering baseline measurements participants were provided with instructional and practice sessions and retested with goals of 20 N and 40 N. Two to three weeks post instruction researchers reassessed subjects' retention using the same parameters. Results indicated a majority of subjects initially provided an inappropriately elevated level of applied force (approximately 65%) that decreased during the 20-second measurement period. Performance improved to within acceptable levels after the first instructional session, and at the 14-21 day follow-up, 12 of 18 subjects successfully demonstrated the maneuver.(17) However, only eighteen individuals participated in the follow-up stage, creating a potentially significant limitation.

Another study recruited 53 operating room personnel consisting of anesthesiologists, residents, CRNAs, nurses, and technicians. To prevent an educational level bias, subjects were grouped into their respective career fields. Using a test/retest design, Herman, Carter, & VanDecar obtained pre-instructional values using a laryngotracheal model. Education was then provided and measurements documented post practice session and at a three month follow-up.

Among the groups, the anesthesia physicians exhibited the lowest pre-instruction average (6.6 N) on the simulated awake patient. Researchers considered 20 N the correct awake pressure and 40 N the appropriate unconscious pressure. After the practice session 22.2 N was the cumulative average of all groups. Pre-instructional values for the simulated unconscious patient yielded unacceptably low forces. Again the physician faculty had the lowest cumulative average (12.5N). However, after instruction and the practice session the average of all groups increased to 39.0 N. Furthermore, at the three-month follow-up subjects continued to provide force within the acceptable range (38.6 N). Results substantiated that adult learners improve performance after an educational intervention and that a majority of individuals retained the skill at follow-up.(18)

Studies support a general lack of knowledge about the proper application of cricoid pressure exists among anesthesia and operating room providers. Research suggests retention of knowledge and the ability to perform the technique appropriately may last for weeks to months, with teaching and practice on models. Based on deficiencies and gaps within available literature new research is warranted.

Methods

After IRB approval, a convenience sample of 14 active duty operating room nurses assigned to Wright Patterson Air Force Base in Dayton, Ohio were recruited for the study. There were no potential risks to participants in this study. There were, however, several benefits. Subjects received an instant competency assessment, educational information, and an opportunity to practice the technique. Inclusion criteria for this study were that these nurses hold a minimum of a baccalaureate degree in nursing. No potential participant was denied inclusion based on gender, race, or age. No volunteers were accepted into the study whose physical disabilities precluded proper performance of the technique. This included pregnancy beyond the

sixth month of gestation. Participants served as their own control group due to baseline data collection before any educational intervention occurred.

The research consisted of a quasi-experimental design to examine cause-and-effect relationships. Success of an educational intervention was evaluated via a test-retest method immediately after teaching and at a 2-month follow-up. After participant recruitment, researchers proceeded with consent and data collection. Subjects were asked to consent for the duration of the study. Participation was entirely voluntary and subjects were informed that they could withdraw at any time during the course of the study.

Demographic data was also collected for analytical purposes in the final report. All information was recorded on a standard collection tool and data was kept confidential. Initial instruction and teaching session were practiced prior to interacting with subjects to prevent bias from instructor methods improving over time. Subjects were briefed on methods employed to gather data and were asked to complete a one-page document containing open-ended questions about appropriate force and technique during application of cricoid pressure.

After collection of the questionnaires, participants assembled in the hallway for data collection on the laryngotracheal model. Subjects entered the data collection room individually to simulate cricoid pressure prior to receiving the educational intervention from one of two instructors. A Laerdal Airway Management Trainer, model 250000, provided realistic anatomical features. The model was placed on an appropriately sized scale that measured in kilograms and was calibrated prior to the initial educational intervention and again at the follow-up. After baseline data collection researchers taught the importance of correctly placed cricoid pressure, the anatomical location of the cricoid cartilage, the correct amount of pressure to apply, and duration that pressure should be held. All subjects had the opportunity to practice

individually in a private setting for 15 minutes prior to post-test data collection. All initial and follow-up data were collected in an identical manner.

Duration of force applied during application of cricoid pressure is a component of appropriate technique. The release of pressure prior to confirmation of successful intubation increases risk of passive regurgitation. As a result of this concept, researchers collected data on the ability to maintain adequate force for 60 seconds, an acceptable length of time in which to accomplish intubation. Ability to maintain a consistent force was recorded beginning at the point the subject verbalized that he/she was holding correct pressure and was assessed for 60 seconds. The initial pressure, the final pressure at 60 seconds, and the low and high points during the 60 second measurement were recorded.

At the 2-month follow-up, data collection focused on retest of performance and knowledge. Researchers did not provide remediation on technique. Individuals again completed the same document with open-ended questions provided during the pretest session and simulated cricoid pressure for a duration of 60 seconds. Researchers collected data on application of force using the laryngotracheal model in an identical manner to prior sessions. During the initial data collection period and at the follow-up all efforts were made to collect data in as narrow a time frame as possible to reduce situational bias and maintain integrity of the study.

Results

A total of 14 nurses participated in trials one and two of the study. Trial one was considered the baseline pressure measurement prior to instruction. Trial two was the measurement taken after instruction and practice session. Ten nurses participated in trial three, the re-test at two months. The discrepancy in availability was due to leave and deployment. For the purposes of the study an alpha less than 0.05 was considered significant. Responses on the

usual number of times cricoid pressure was performed by each nurses in the perioperative in a month ranged from 2-20, with a median of 5, and a mode of 4. One subject chose not to answer the initial knowledge question and is excluded from analysis of this variable.

Overall, only 14.0% of the participants could correctly identify the accepted range for cricoid pressure as being 3-4 kilograms. Previous education did not seem to significantly affect knowledge. Results of the questionnaire indicated that 35.7% of subjects had received formal training on the application of cricoid pressure prior to the intervention in this study. However, only 40.0% (n=3) of these previously trained participants answered correctly, while12.5% (n=1) of the participants without prior training answered correctly. This relationship between prior training and knowledge was not statistically significant (X^2=1.31, Fishers exact p=.25).

Years of nursing experience was compared to the initial knowledge of correct pressure. Due to the small sample size, subjects were grouped into 0-9 years (n=6) and 10 and over years of experience (n=7). Results indicated that 28.6% (n=2) of nurses with greater than nine years experience correctly identified an appropriate pressure, while only 16.7% (n=1) of participants with less than 9 years nursing experience responded correctly. The relationship between experience and knowledge was likewise not statistically significant (X^2=0.61, Fishers exact p>.99).

Years of operating room experience did not appear to play a significant role in baseline knowledge of correct pressure. Experience ranged from 0.5 to 36 years, with a median of 9.7 years. Again, based on the small sample, subjects were split for the comparison by years of experience into two groups: 0-4 years (n=6) and 5 years and over (n=7). Nurses with 5 years experience or more correctly identified an appropriate pressure only 14.3% of the time (n=1). While 33.3% (n=2) of the less experienced nurses were able to state a correct pressure initially,

the relationship between knowledge and operating room experience was not statistically significant ($X^2 = 0.660$, Fishers exact p=0.437).

Nurses participating in the study simulated cricoid pressure on a scale-mounted laryngotracheal model. Pressure was held for a duration of 60 seconds and measurements recorded at the start and finish points, as well as the low and high points within the timeframe. Refer to Tables 1 and 2 for the results of all three trials. During base line data collection a total of 50% held the correct amount of pressure at the start point. At the end of the 60 seconds, only 35% utilized the appropriate pressure. Pressures applied ranged from a low of 0.4 kg to a high of 7.8 kg.

After an educational intervention and practice period, again 50% of participants simulated appropriate cricoid pressure at the start point, however at 60 seconds only 21% still held correct pressure. The range of variation was much smaller, however, with measurements ranging from 1.6-4.1 kg. It must be noted that performance was inconsistent even for the same subject. Four subjects performed correctly in trial one, but incorrectly in trial two. Another four subjects applied incorrect pressure in trial one and correct pressure in trial two. Three were incorrect both times and three correct both times. Not surprisingly, statistical analysis using McNemar's test showed that there was no significance difference between the trials ($p<0.99$).

Trial three data collection occurred at the two-month follow-up. Seventy percent of participants performed correct cricoid pressure at the start point, in addition, at 60 seconds 60% still held an appropriate pressure. Measurements ranged from 2.7-6.8 kg. Interestingly, four subjects held incorrect pressure at the post-test, but correctly at the follow-up. One person used correct pressure at the post-test yet incorrect at the follow-up. Two subjects were incorrect in

both trials and three subjects correct both times. Again, not surprisingly, using McNemar's test showed there was no significance difference between the trials ($p<0.99$).

Discussion

Data indicated that operating room nurses do not apply cricoid pressure correctly. Prior to educational intervention only 50% of participants performed the technique appropriately. The finding is supported by earlier research and seems fairly consistent among studies on cricoid pressure.(19) Interestingly, on the questionnaire only 14% of participants correctly answered within the accepted 3-4 kg of pressure. When compared to the 50% baseline success rate, this suggests that appropriate performance is not necessarily related to knowledge.

Results indicated that an educational intervention did not immediately improve performance. Modern studies that have undertaken an educational session improving application of the technique have indicated improvement.(20) Logically, a person would be expected to perform correctly after receiving instruction and practicing a newly acquired skill. Our results may likely have been limited by the small sample size.

Limited research is available on whether healthcare providers retain the knowledge and ability to perform cricoid pressure correctly. The results of this study indicate that the skill is retained. At the two month follow-up, 90% of participants correctly answered the amount of pressure and 70% applied an appropriate amount of pressure. This finding is supported by the prior work of Herman, Carter and VanDecar.(21)

Findings from this study yielded inconsistent performance throughout. It is not unreasonable to expect the success rate of a skill to improve after an educational intervention. Results indicated a 50% success rate at baseline and post-test data collection points. At the two month follow-up, when results may have been expected to remain consistent or decrease,

successful application increased to 70%. Part of the inconsistency may be attributable to the small sample size. However, the possibility exists of a disconnect between knowledge and performance. The ability to conceptualize applying 3-4 kg of force may have presented an obstacle that turned the skill into chance once the subjects could not visualize the scale read out.

Neither years of nursing experience or operating room experience were found to have an impact on baseline knowledge of appropriate cricoid pressure. Though not statistically significant, 33.3% of nurses with less than five years operating room experience compared to 14.3% with greater than five years had baseline knowledge of correct pressure. Perhaps operating room courses have incorporated cricoid pressure teaching into modern programs.

The data indicated an inconsistent relationship between knowledge and performance. Of the 14% of subjects who correctly answered the amount of pressure to apply, only 33% simulated the skill on the model correctly. Part of the discrepancy may have been due to the small sample size. Other contributing factors may have been a bewildering educational session and/or waning interest. Also, the ability to not know and yet perform correctly may be attributable to correct being a pressure measurement. Incorporating elements such as technique and duration would have required increasing knowledge and may have reduced the incidence of incorrect knowledge yet correct application of pressure.

Data indicated the range of pressures decreased after the participants received the educational intervention. Initially pressures at baseline collection ranged from 0.4-7.8 kg with a difference of 7.4 kg. After the teaching and practice session, post-test pressures ranged from 1.6-4.1 kg with a difference of 2.5 kg. Even though only 50% of participants fell within the correct range of 3-4 kg at trial two, the narrowed range of measurements suggests that instruction and

practice positively impacted ability to perform the technique. Tables 3, 4, and 5 illustrate the narrowed range of pressures.

The measurements collected at the 60 second point for all three trials suggest that participants decrease the amount of pressure during the course of a minute. Table 6 illustrates the range of values and the pressure applied at 60 seconds. Proper performance of the technique maintains pressure within an acceptable range until endotracheal intubation, inflation of the cuff, and confirmation of correct placement. Significantly too little pressure before confirming proper of the endotracheal tube placement negates the beneficial effect of cricoid pressure and may increase the risk of gastric regurgitation and subsequent pulmonary aspiration.

Limitations

Though the convenience sample of operating room nurses was an appropriate choice given that application of cricoid pressure is often their responsibility, the small sample size in this study was a significant limitation. Unfortunately, the ability to infer the findings to larger populations of operating room nurses is also restricted by the small sample size. Undertaking a larger study with increased numbers of participants would increase the applicability to other operating room populations and increase the likelihood of statistical significance. Though pertinent, confining the sample population to operating room nurses limits the ability to generalize the findings to other nursing specialties. Lastly, sampling military nurses may have introduced a bias.

Due to time restrictions this research was more of a cross-sectional rather than a longitudinal study. Traditionally, retention of knowledge is measured over time. The two-month point may have been too early a time frame for retesting and an additional follow-up period may

have indicated the anticipated outcomes. A longitudinal design with three and six month follow-ups may have proved more efficacious in determining the desired results.

Conclusion

Strategies to improve performance optimize outcomes. This is especially pertinent in the operating room setting when outcome refers to patients. Studies support that a general lack of knowledge and improper application of cricoid pressure exists among anesthesia and operating room providers. This study concurred with prior research regarding lack of baseline knowledge and performance results, yet positive retention outcomes. According to modern research, performance improves with teaching and practice on models.

Literature concerning the significance of cricoid pressure readily available to nurses lacks substance. Because of limited studies on learning and retention, further research is warranted. A larger sample size would potentially negate many of the limitations of this study. Furthermore, utilizing more than one site for data collection allows for a traditional control group, and including civilian providers in the sample may expand the ability to generalize the results. Also, conducting more of a cross-sectional design over a time frame of 3 or even 6 months may be more representative of actual retention results.

The technique of cricoid pressure, as first suggested by Sellick is effective in reducing the incidence of regurgitation in high-risk patients. In many settings, it is a circulating nurse that is responsible for applying cricoid pressure in the prevention of passive regurgitation and subsequent gastric aspiration. Consequently, a knowledgeable and proficient perioperative nurse capable of delivering appropriate cricoid pressure is extremely important

The views expressed in this paper are those of the authors and do not reflect the official policy or position of the Uniformed Services University of the Health Sciences, United States Air Force, Department of Defense, or the US Government.

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References

(1) B A Sellick, "Cricoid pressure to control regurgitation of stomach contents during induction of anaesthesia," *Lancet* 2 (1961) 404-405.

(2) J R Brimacombe, A M Berry, "Cricoid pressure," *Canadian Journal of Anaesthesiology* 44 (1997) 414-425.

(3) B A Sellick, "Cricoid pressure to control regurgitation of stomach contents during induction of anaesthesia," *Lancet* 2 (1961) 404-405.

(4) M R Salem, B A Sellick, J O Elam, "The historical background of cricoid pressure in anesthesia and resuscitation," *Anesthesia and Analgesia* 53 (1974) 230-232.

(5) B A Sellick, "Cricoid pressure to control regurgitation of stomach contents during induction of anaesthesia," *Lancet* 2 (1961) 404-405.

(6) J R Brimacombe, A M Berry, "Cricoid pressure," *Canadian Journal of Anaesthesiology* 44 (1997) 414-425.

(7) C A Koziol, J D Cuddeford, D D Moos, "Assessing the force generated with application of cricoid pressure," *The Association of Operating Room Nurses* 72 (2000) 1018-1030.

(8) R G Vanner, T Asai, "Safe use of cricoid pressure," *Anaesthesia* 54 (1999) 1-3.

(9) S Brookfield, "Adult learning: an overview," *International Encyclopedia of Education,* ed A Tuinjman (Oxford: Pergamon Press, 1995).

(10) J E Billi, G E Membrino, "Education in adult advanced cardiac life support training programs: changing the paradigm," *Annals of Emergency Medicine* 22 (1993) 475-483.

(11) T M Cook, "Cricoid pressure: are two hands better than one?" *Anaesthesia* 51 (1996) 365-368.

(12) T M Cook, I Godfrey, M Rocket, R G Vanner, "Cricoid pressure: which hand?" *Anaesthesia* 55 (2000) 648-653.

(13) C A Koziol, J D Cuddeford, D D Moos, "Assessing the force generated with application of cricoid pressure," *The Association of Operating Room Nurses* 72 (2000) 1018-1030.

(14) A Schmidt, J Akeson, "Practice and knowledge of cricoid pressure in southern Sweden," *Acta Anaesthesiologica Scandinavica* 45 (2001) 1210-1214.

(15) T Meek, N Gittins, J E Duggan, "Cricoid pressure: knowledge and performance amongst anaesthetic assistants," *Anaesthesia* 54 (1999) 59-62.

(16) T J Clayton, R G Vanner, "A novel method of measuring cricoid force," *Anaesthesia* 57 (2002) 326-329.

(17) N Ashurst, C C Rout, D A Rocke, E Gouws, "Use of a mechanical simulator for training in applying cricoid pressure," *British Journal of Anaesthesia* 77 (1996) 468-472.

(18) N L Herman, B Carter, T K Van Decar, "Cricoid pressure: teaching the recommended level," *Anesthesia and Analgesia* 83 (1996) 859-863.

(19) C A Koziol, J D Cuddeford, D D Moos, "Assessing the force generated with application of cricoid pressure," *The Association of Operating Room Nurses* 72 (2000) 1018-1030. T Meek, N Gittins, J E Duggan, "Cricoid pressure: knowledge and performance amongst anaesthetic assistants," *Anaesthesia* 54 (1999) 59-62. N Ashurst, C C Rout, D A Rocke, E Gouws, "Use of a mechanical simulator for training in applying cricoid pressure," *British Journal of Anaesthesia* 77 (1996) 468-472. N L Herman, B Carter, T K Van Decar, "Cricoid pressure: teaching the recommended level," *Anesthesia and Analgesia* 83 (1996) 859-863.

(20) T Meek, N Gittins, J E Duggan, "Cricoid pressure: knowledge and performance amongst anaesthetic assistants," *Anaesthesia* 54 (1999) 59-62. N L Herman, B Carter, T K Van Decar,

"Cricoid pressure: teaching the recommended level," *Anesthesia and Analgesia* 83 (1996) 859-863.

(21) N L Herman, B Carter, T K Van Decar, "Cricoid pressure: teaching the recommended level," *Anesthesia and Analgesia* 83 (1996) 859-863

Figure 1

Conceptual Framework

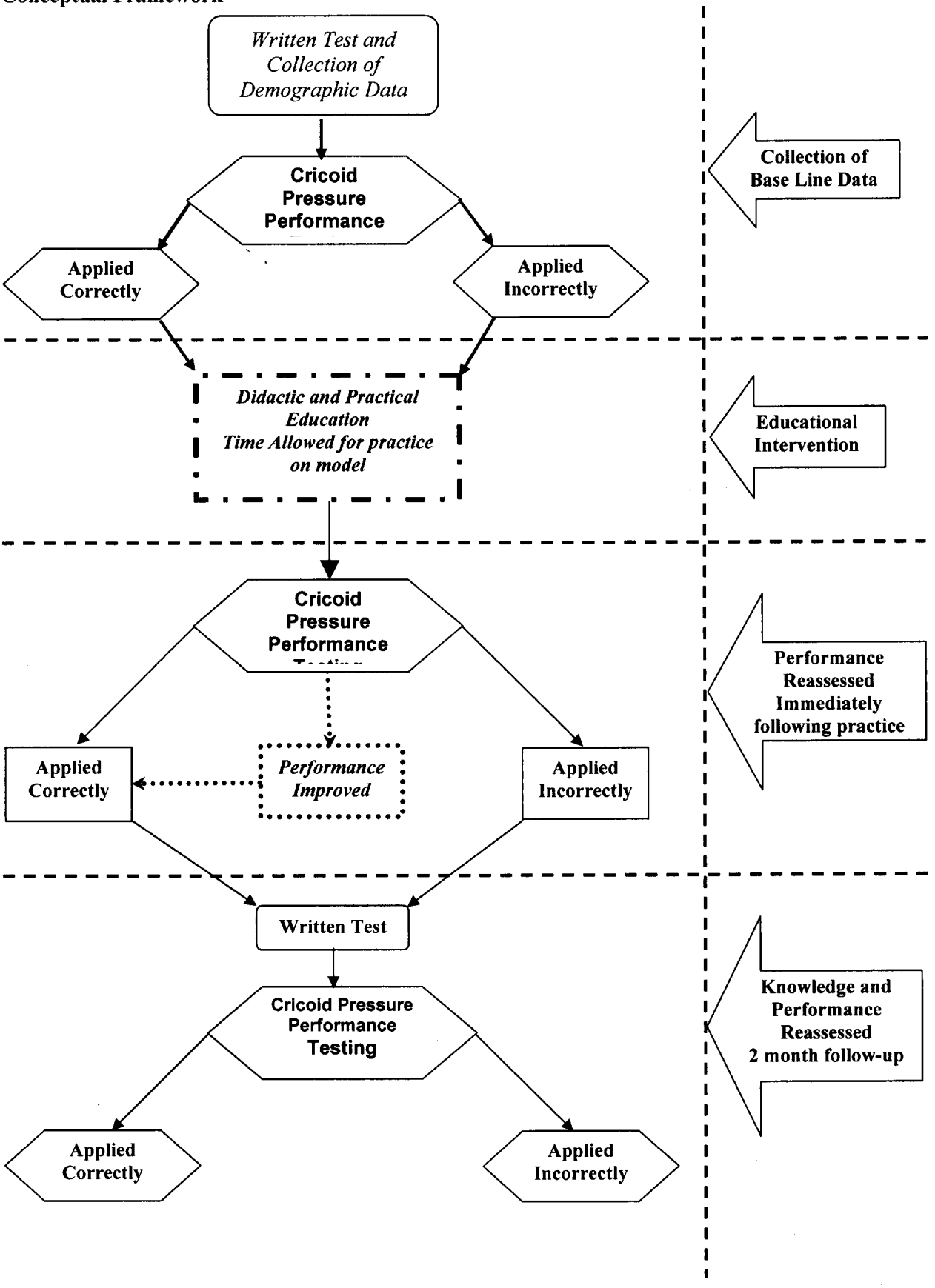


Table 1

Outcome table

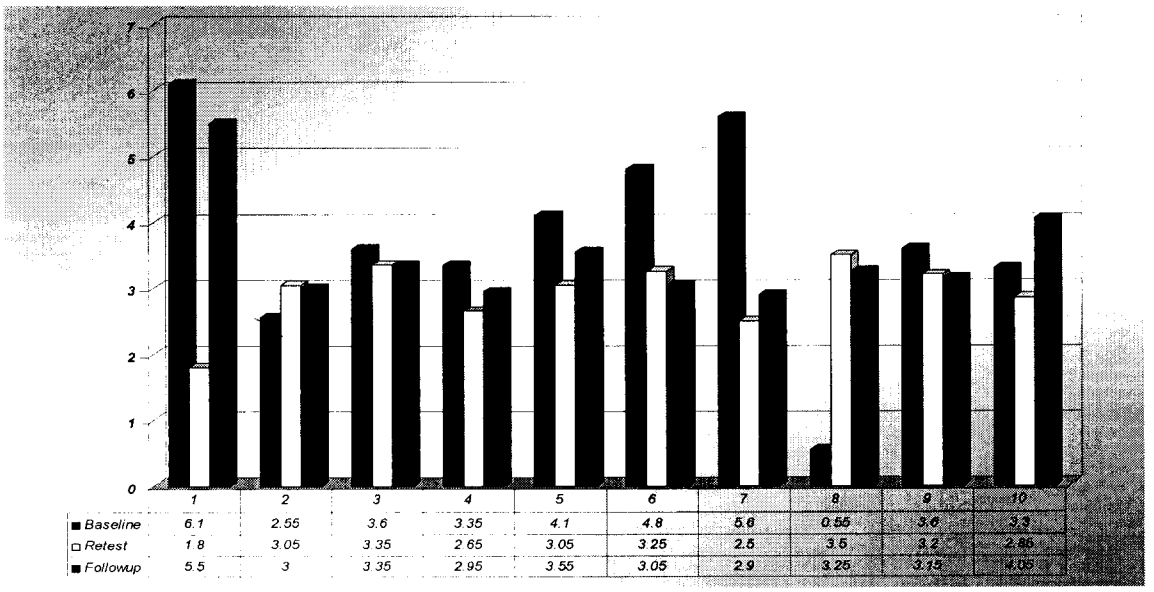
	Beginning Pressure (kg)	Low Pressure (kg)	High Pressure (kg)	Final Pressure (kg)	P value
Baseline	3.51	2.81	4.12	2.90	NS
Post-test	2.98	2.53	3.31	2.73	NS
2month follow-up	3.71	3.08	3.87	3.18	NS

NS- not statistically significant

Table 1. Outcome table for all three trials. Listed are means for each data collection point. No comparisons were significant with a $p < 0.05$.

Table 2

Average Pressure Applied



	1	2	3	4	5	6	7	8	9	10
■ Baseline	6.1	2.55	3.6	3.35	4.1	4.8	5.6	0.55	3.6	3.3
□ Retest	1.8	3.05	3.35	2.65	3.05	3.25	2.5	3.5	3.2	2.85
■ Followup	5.5	3	3.35	2.95	3.55	3.05	2.9	3.25	3.15	4.05

Table 2. Mean pressure applied by each participant for each of the three trials. Largest variability occurred during baseline collection prior to educational intervention.

Table 3

Baseline Data

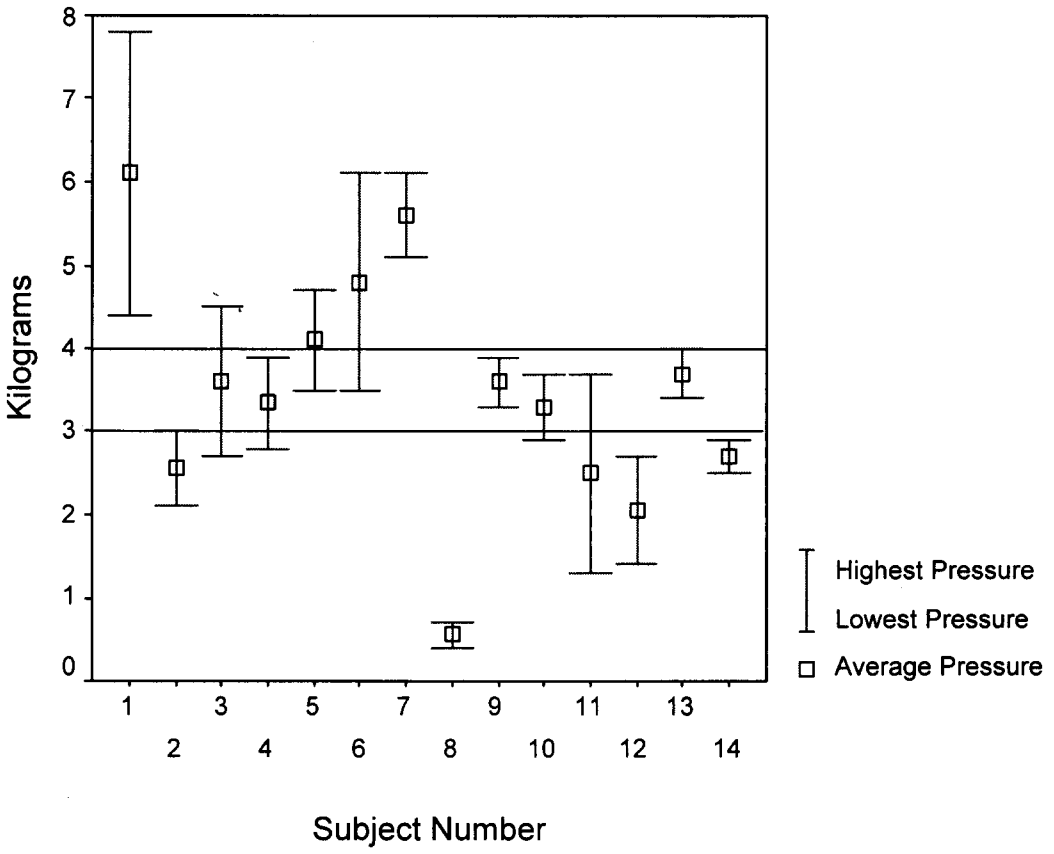


Table 3. Fifty percent held the correct amount of pressure at the start point. At 60 seconds, only 35% utilized the appropriate pressure. Pressures applied ranged from a low of 0.4 kg to a high of 7.8 kg.

Table 4

Post-test Data

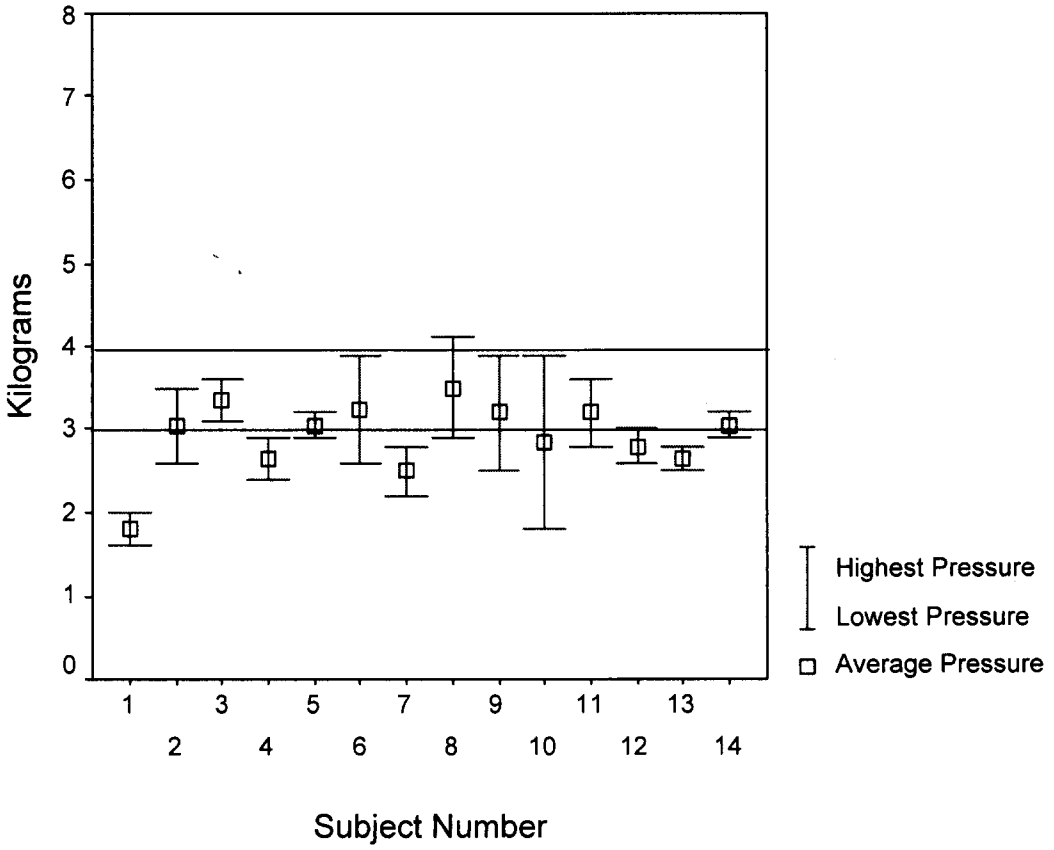


Table 4. Again 50% of participants simulated appropriate cricoid pressure at the start point. At 60 seconds only 21% still held correct pressure. The range of variation was 1.6-4.0.

Table 5

Follow-up Data

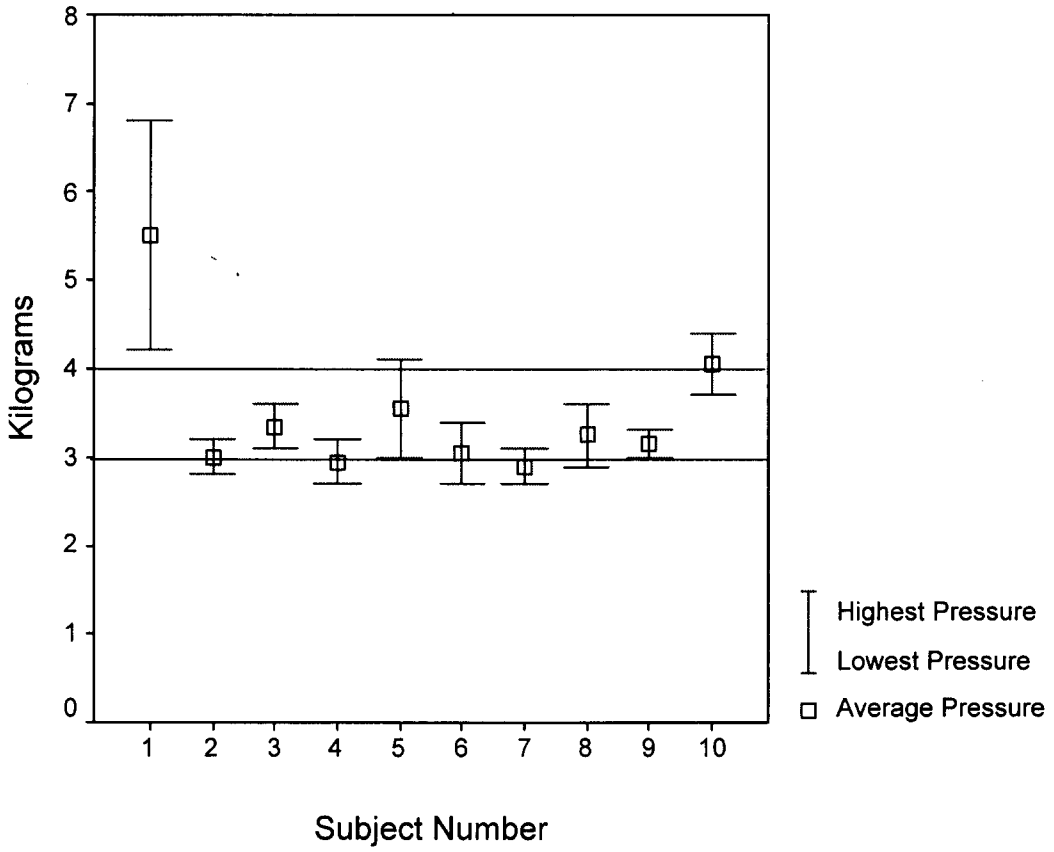


Table 5. Seventy percent of participants performed correct cricoid pressure at the start point. At 60 seconds 60% still held an appropriate pressure. Measurements ranged from 2.7-6.8 kg.

Table 6

Pressure at 60 seconds

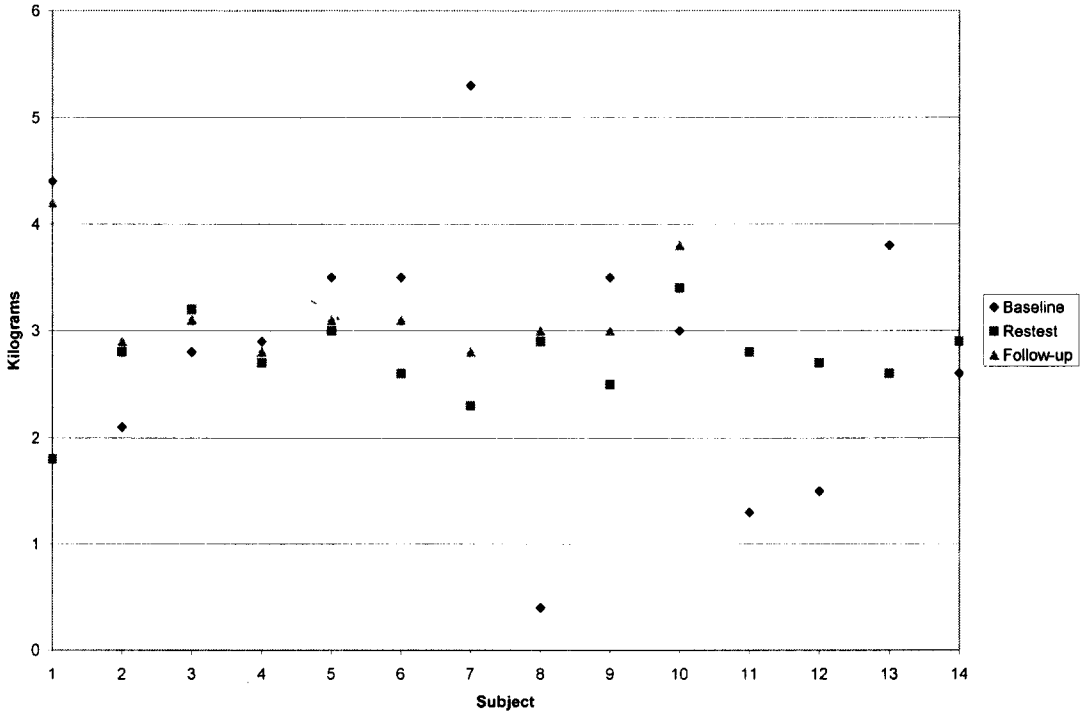


Table 6. Measurements collected at the 60 second point for all three trials suggest pressure decreases during the course of a minute. Illustrated is the pressure applied at 60 seconds for each participant.